【SPECIFICATION】

【TITLE OF THE INVENTION】

METHOD FOR FABRICATING ORGANIC ELECTROLUMINESCENT DISPLAY

【BRIEF DESCRIPTION OF THE DRAWINGS】

FIG. 1 is a graph for illustrating an energy distribution of a laser beam used for a conventional thermal transferring method.

FIG. 2 is a schematic view for illustrating a method for forming a pattern using a conventional thermal transferring method.

FIG. 3 is a block diagram for illustrating a method for fabricating an organic electroluminescent display.

FIG. 4 is a schematic view of an organic electroluminescent display fabricated according to a method shown in FIG. 3.

FIG. 5 is a schematic view for illustrating a method for fabricating an organic electroluminescent display according to a first embodiment of the present invention.

FIGS. 6 to 8 are schematic views for illustrating dithering examples of a laser beam used for the present invention.

FIG. 9 is a graph for illustrating a sectional energy distribution of a laser beam used for the present invention.

FIG. 10 is a schematic view for illustrating a method for fabricating an organic electroluminescent display according to a second embodiment of the

present invention.

FIG. 11 is a schematic view for illustrating a method for fabricating an organic electroluminescent display according to a third embodiment of the present invention.

FIG. 12 is a schematic view for illustrating a method for fabricating an organic electroluminescent display according to a fourth embodiment of the present invention.

FIG. 13 is a schematic view for illustrating a transferring apparatus used for the present invention.

FIG. 14 is a block diagram for illustrating a method for fabricating an organic electroluminescent display according to another embodiment of the present invention.

FIG. 15 is a graph for illustrating a sectional energy distribution of a laser beam applied to another embodiment of the present invention.

【DETAILED DESCRIPTION OF THE INVENTION】

【Object of the Invention】

【Field of the invention and description of the related art】

The present invention relates to a method for fabricating an organic electroluminescent display, and more particularly, to a method for fabricating an organic electroluminescent display having improved surface flatness and thickness uniformity as well as an improved image quality at edge regions of a pattern.

An electroluminescent display includes an electroluminescent material disposed between electrodes, and is designed to realize an image by applying a voltage to the electrodes so as to form an electric field therebetween such that the electroluminescent material may become luminescent. Such an electroluminescent display is classified into an inorganic electroluminescent display and an organic electroluminescent display depending on the electroluminescent material. The inorganic electroluminescent display has been put into practical use and is widely used for a backlight of a watch, and the organic electroluminescent display is under strong investigation since it shows merits of high luminance and efficiency, drivability by a low voltage, and high responsiveness, in comparison with the inorganic one.

Generally, such an organic electroluminescent display includes a transparent substrate, on which an anode electrode, an organic luminescent layer, and a cathode electrode are consecutively disposed.

The organic luminescent layer may have a variety of structures depending on an electroluminescent material. For example, the organic luminescent layer may be formed of a hole transport layer, an luminescent layer, and an electron transport layer, or of a hole transport layer and an electron transport/luminescent layer, or of a hole transport/luminescent layer.

In the above described organic electroluminescent display, the organic luminescent layer is designed to realize red (R), green (G), and blue (B) colors so that it can be applied to a color display.

Such an organic luminescent layer is generally formed through a vacuum evaporative deposition process using a shadow mask or through a

conventional optical etching process. However, the vacuum evaporative deposition process has a limitation in reducing the physical gap between the patterns and it is difficult to form a minute pattern to tens of μm level which is required against the possible deformation of the mask. When the optical etching process is applied, although it is possible to form the minute pattern, practical application becomes difficult since the property of the luminescent material forming the organic luminescent layer may be deteriorated by the developing solution or the etching solution.

Therefore, a thermal transferring method that is a kind of dry etching processes has been recently proposed to form the organic luminescent layer.

The thermal transferring method converts light emitted from a light source into thermal energy by which an image formation material is transferred to a substrate to form a color pattern. Therefore, to perform the thermal transferring method, a light source, a donor film and a substrate are required.

That is, as for a brief description of formation of a color image according to thermal transferring method, a light emitted from a light source such as a laser is scanned on a donor film to be absorbed by absorbent of the donor film such that the light becomes converted to thermal energy, and color material of the donor film is transferred to a surface thereof by the thermal energy.

Actually, according to the thermal transferring method, a color image is formed by scanning a laser beam of a desirably adjusted focus to the donor film disposed on the substrate according to a desired pattern.

For an example of such a prior art, U.S. Patent No. 5,521,035 discloses a method for fabricating a color filter for a liquid crystal display through a laser

thermal transferring process.

In this patent, the color filter is fabricated by a laser induction thermal transferring process for transferring a color material from a donor film to a substrate such as a glass or a polymeric film. As a laser unit, an Nd:YAG laser system is used for transferring the color material to the surface of the substrate.

The Nd:YAG laser forms a Gaussian beam having a distribution of a Gaussian function shape. When a diameter of the Gaussian beam is set large (approximately, above 60μm), the inclination of the energy distribution is slowly reduced as it goes away from the center point.

Therefore, as shown in FIG. 2, when the Gaussian beam 110 having a predetermined diameter is scanned in an X-direction as shown in FIG. 2, since the beam intensity is low at the both edges of a color pattern 112, the quality of the color pattern 112 at the both edges is deteriorated when compared with the central portion.

【Object to be achieved by the present invention】

When the energy of the laser beam is intensified to improve the image quality at the edges in order to solve the above problem, although the image quality at the edges may be enhanced, the surface of the image pattern becomes irregular since the energy is excessively increased at the central potion.

At this point, the present invention has been made to solve the problem, and an objective of the present invention it to provide a method for fabricating an organic electroluminescent display having an improved surface flatness and

thickness uniformity as well as an improved image quality at edge regions of a pattern

【Constitution and Operation of the Invention】

In order to achieve the objective, the present invention provides a method for fabricating an organic electroluminescent display wherein a laser beam is dithered in a direction perpendicular to a scanning direction of the laser beam while forming an organic luminescent layer on the assistant layer by scanning a donor film using a laser beam, the donor film being disposed on the substrate having luminescent materials for R, G, and B.

In addition, the present invention provides a method for fabricating an organic electroluminescent display wherein a single laser beam formed by a composition of a laser beam having gentle inclination in energy distribution and a laser beam having steep inclination in energy distribution such that inclination in energy distribution is increased at a threshold energy is utilized while forming an organic luminescent layer on the assistant layer by scanning a donor film using a laser beam, the donor film being disposed on the substrate having luminescent materials for R, G, and B.

Thereby, thermal transferring at a pattern edge of an organic luminescent layer is ensured.

Preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

FIG. 3 is a block diagram for illustrating a method for fabricating an organic electroluminescent display, and FIG. 4 is a schematic view of an

organic electroluminescent display fabricated according to a method shown in FIG. 3.

As shown in the drawings, first electrode layers 12 having a thickness of about 100-500nm is formed on a transparent substrate 10 by sputtering indium tin oxide (ITO).

An assistant layer (hole transport layer) 14 having a thickness of about 10-100nm is formed on the first electrode layer 12 by, for example, a spin coating process, a dip coating process, a vacuum evaporative deposition process, or a thermal transferring process. An R-G-B organic luminescent layer 16 is formed on the assistant layer 14 by a thermal transferring process. A second electrode layer 18 intersecting the first electrode layer is formed on the organic luminescent layer 16.

Here, An insulating layer formed of an organic material such as polymer photoresist or an inorganic material such as SiO_2 and SiN_2 may be deposited between the line patterns of the first electrode. The second electrode layer 18 may be formed by depositing aluminum through a vacuum evaporative deposition process at a thickness of about 50-1500nm.

In addition, for an increase of an efficiency, a material such as LiF may be disposed between the organic luminescent layer and the second electrode layer.

In order for forming an organic luminescent layer by a thermal transferring method, a donor film formed of a base film, a light absorption layer, and a transfer layer is required, and a desired pattern of the emission layer is obtained by scanning a laser beam after disposing the donor film on an upper

side of a substrate provided with the first electrode layer and the assistant layer

In order for fabricate a full colored organic electroluminescent display, three donor films for the three colors of R, G, and B is required, and emission patterns of R, G, and B may be obtained by three times of scanning process on respective donor films.

Emission pattern of an organic electroluminescent display should show flatness on the surface, high image quality at the edges, and uniform thickness distribution. Therefore, in order for forming an organic emission layer by a thermal transferring method, it is preferable that energy distribution of a laser beam scanned on the donor film is uniform and shows rapid inclination near the edges such that width may not fluctuate due to non-uniform sensitivity of the donor film.

Therefore, it necessitates an alteration of laser beam from energy distribution of Gaussian shape such that energy is decreased in its central portion while energy distribution rapidly change near the edges. For such an alteration of an energy distribution, according to the present invention, the laser beam may be dithered in a perpendicular direction with respect to a scanning direction of the beam, or a single beam composed of a plurality of laser beams having different energy distribution. The scheme of dithering a laser beam is first described.

FIG. 5 is a schematic view for illustrating a method for fabricating an organic electroluminescent display according to a first embodiment of the present. In the drawing, the reference numeral 20 indicates a pattern of a organic luminescent layer to be formed on an assistant layer.

And, the reference numeral 22 indicates a laser beam as a light source for scanning the pattern 20.

The laser beam 22 moves in an X-direction shown in the drawing (i.e., from the left to the right in the drawing) along the pattern 20 to perform the scanning process. At this point, differently from the prior art, while moving in the X-direction, the laser beam 22 dithers in a Y-direction.

By the dithering movement of the laser beam 22, the thermal 10 transferring process is effectively realized even at both edges 20a and 20b of the pattern 20. The dithering movement is realized by alternating the advancing direction of the laser beam under the control of an acousto-optic modulator (AOM).

In addition, the dithering speed is preferably higher than the scanning speed. In more detail, considering the scanning speed and the energy distribution, it is preferable to set the dithering speed at about 100-10,000 KHz.

Although the section of the laser beam 22 may be formed in various shapes such as a circular or an oval shape, an oval shape is more preferable. Particularly, in the case that the pattern 20 of the organic luminescent layer is formed lengthily in a lengthwise direction as shown in the drawing, it is preferable that the section of the oval-shaped laser beam 22 is designed to have its major axis aligned in the scanning direction of the beam, since energy distribution applied to the pattern 20 may become uniform over entire portion thereof due to an increase of overlapping ratio of the beam during scanning.

When the lateral width W of the pattern 20 is 60-150μm, it is preferable that the section of the laser beam is oval-shaped having its major axis of 200-

500μm and its minor axis of 15-50μm.

As shown in FIGS. 6 to 8, the laser beam performs its scanning operation along a waveform of a sine wave (see FIG. 6), a saw-tooth wave (see FIG. 7), or a trapezoidal wave (see FIG. 8). At this point, the sectional energy distributions of the laser beam 22 for the waveforms are as shown in FIG. 9.

As shown in FIG. 9, when the laser beam performs its scanning operating without the dithering movement, the laser beam (i.e., Gaussian beam B1) has an energy distribution having an inclination gently reduced as it goes from the central portion to the edges of the pattern.

However, the laser beam 22 of the present invention has an energy distribution having an inclination steeply increased as it goes from the central portion to the edges of the pattern (See graphs B2 and B3 in FIG. 9 which respectively represent the laser beams performing their dithering movements in the shape of the sine wave and the trapezoidal wave).

Based on such energy distributions, it is found that the intensity of the laser beam 22 of the present invention is not reduced even at the edges 20a and 20b of the pattern 20 thereby effectively realizing the thermal transferring process there.

In addition, the laser beam 22 according to the present invention has similar intensity at its central portion and its edge portion, and accordingly, surface roughness of the pattern 20 may be prevented.

That is, when the beam intensity is increased to compensate for the intensity of the beam edge as in the conventional laser beam B1, the surface of the pattern becomes uneven. However, the laser beam of the present invention

has the beam intensity throughout its entire area, there is no need to increase the beam intensity to compensate for the beam edge. As a result, the flatness of the pattern can be improved.

In the above-described first embodiment, a single laser beam is radiated from a single laser unit. However, the present invention is not limited to this.

That is, the laser beam 22 may be formed in various manners to form organic luminescent layer by a thermal transferring method, and another embodiment for the various manners is as follows.

FIG. 10 is a drawing for illustrating a method for fabricating an organic electroluminescent display according to a second embodiment of the present invention. According to the present embodiment, That is, as shown in FIG. 10, plural split laser beams 22 and 22' may be radiated from a single laser unit (not shown) so that plural organic luminescent layer patterns 20 and 20' are simultaneously scanned while dithering the laser beams 22 and 22'.

Preferably, the plural split laser beams 22 and 22' are synchronized.

When the plural laser beams 22 and 22' are dithered and scanned synchronously, a plurality of organic luminescent layer patters are simultaneously formed by one operation.

In addition, differently from the second embodiment, a plurality of laser beams may be used for forming an organic luminescent layer.

FIGS. 11 and 12 are drawings for illustrating such a scheme. Firstly in FIG. 11, plural laser beams radiated from plural laser units (not shown) are overlapped one another to form a single overlapped laser beam 32 (in this case, each laser beam has the same energy distribution), and they are dithered and

scanned.

That is, according to a third embodiment of the present invention, for example, lasers from two laser units are overlapped to be unified and they are dithered while scanning. According to such a scheme, beam intensities are doubled relative to laser beam from a single laser unit, and accordingly, scanning speed may be increased.

Alternatively, as shown in FIG. 12, plural laser beams 42 and 44 may be radiated from plural laser units (not shown) so as to perform the scanning operation with different phases without overlapping.

At this time, the plural laser beams have equal energy distribution.

In addition, the plural laser beams may be applied to adjacent organic luminescent layer patterns as shown in FIG. 10 so as to fabricate organic luminescent display by dithering and scanning. The plural laser beams are preferably synchronized.

FIG. 13 shows a thermal transferring apparatus used for the present invention.

Referring to the drawing, a high energy laser beam is radiated from a light source, i.e., a laser unit 50. A high energy solid laser such as a Nd/YAG laser or a gas laser such as a CO_2 laser are used as the light source.

As described above, the radiated laser beam may be either of a single laser beam radiated from one or more lasers or split laser beams formed by a splitting of such a single laser beam with equal intensity by a splitter.

The single laser beam or the split laser beams is adjusted in its intensity by a modulator 52 and then reach a scanning mirror 56 via a first lens array 54.

The scanning mirror 56 guides the laser beam to a target position on the substrate in the X-direction.

The laser beam that has reached the scanning mirror 56 is emitted, through a second lens array 58, to the donor film 60 on which a luminescent material is deposited. Then, the luminescent material deposited on the donor film 60is transferred to the substrate 62, only at a portion scanned by the laser beam.

The donor film 60 and the substrate 62 are supported on a stage 64 whose movement is controlled by a computer 66. The computer 66 also controls the scanning mirror 56 through a scanning mirror controller 68.

The dithering movement of the laser beam is controlled by the modulator 52 which is controlled by the computer 66.

In the above description, embodiments are described in connection with various types of dithering the laser beam. However, according to the present invention, an organic luminescent layer may be formed using a single laser beam composed of a plurality of laser beams of different energy distributions, as shown in FIGS. 14 and 15.

The single laser beam B4 is formed by a composition of a laser beam B5 having a large size (i.e., having gentle inclination in energy distribution) and laser beams B6 and B6' having a small size (i.e., having steep inclination in energy distribution).

The single laser beam B4 formed as such may have a steep inclination in energy distribution at a threshold energy, i.e., a minimally required energy for a transferring, and a resultant pattern may have enhanced flatness and edge

characteristics.

forming an organic luminescent layer using a single laser beam mixed plural laser beams having a different inclination in energy distribution

In an embodiment of the present invention, it is preferable that a poly phenylene vinylene (PPV)-based material or a polyfluorene (PF)-based material is used for the organic luminescent layer.

While this invention has been described in connection with what is presently considered to be the most practical and preferred embodiments, the present invention is not limited thereto. Various variations may be realized within the appended claims, detailed description of the present invention, and the drawings, and consequently, such variations should be understood to be within the scope of the present invention.

【Effect of the Invention】

As can be seen from the above description of the constitution and operation of the present invention, according to a method for fabricating an organic electroluminescent display according to the present invention, a Gaussian beam is dithered during scanning or a single beam formed by composition of a plurality of beams having different energy distributions. Therefore, image formation may be enhanced at the edges of the organic electroluminescent display, and quality of a organic electroluminescent layer due to enhanced flatness of the pattern surface.

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【CLAIMS】

【Claim 1】

A method for fabricating an organic electroluminescent display, comprising the steps of:

forming a first electrode layer on a transparent substrate, the first electrode layer being a positive electrode;

forming an assistant layer on the first electrode layer;

forming an organic luminescent layer on the assistant layer by scanning a donor film using a laser beam, the donor film being disposed on the substrate having luminescent materials for R, G, and B;

removing the donor film; and

forming a second electrode layer on the organic luminescent layer, the second electrode layer being a negative electrode,

wherein the step of forming an organic luminescent layer utilizes a single laser beam formed by a composition of a laser beam having gentle inclination in energy distribution and a laser beam having steep inclination in energy distribution so as to have an increased inclination in energy distribution at a threshold energy.

【Claim 2】

A method for fabricating an organic electroluminescent display, comprising the steps of:

forming a first electrode layer on a transparent substrate, the first electrode layer being a positive electrode;

forming an assistant layer on the first electrode layer;

forming an organic luminescent layer on the assistant layer by scanning a donor film using a laser beam, the donor film being disposed on the substrate having luminescent materials for R, G, and B;

removing the donor film; and

forming a second electrode layer on the organic luminescent layer, the second electrode layer being a negative electrode,

wherein the step of forming an organic luminescent layer comprises the step of dithering the laser beam in a direction perpendicular to a scanning direction of the laser beam.

【Claim 3】

A method of claim 2, wherein the laser beam is a single laser beam radiated from a single laser unit.

【Claim 4】

A method of claim 2, wherein the laser beam comprises a plurality of beams split after radiating from a single laser unit.

【Claim 5】

A method of claim 4, wherein the plurality of beams are synchronized and dither during scanning adjacent patterns.

【Claim 6】

A method of claim 2, wherein the laser beam is a single laser beam formed by overlapping of at least two laser beams having equal energy distributions.

【Claim 7】

A method of claim 2, wherein the laser beam comprises a plurality of beams having equal energy distributions.

【Claim 8】

A method of claim 7, wherein the plurality of beams dither with different phases during scanning on a same pattern.

【Claim 9】

A method of claim 7, the plurality of beams synchronously dither during scanning on adjacent patterns.

【Claim 10】

A method of one of claims 2-9, wherein a dithering speed of the laser beam is higher than a scanning speed of the laser beam.

【Claim 11】

A method of claim 10, wherein the dithering speed of the laser beam is about 100-1000kHz.

【Claim 12】

A method of one of claims 2-9, wherein the dithering is performed according to an oscillating waveform of a sine wave.

【Claim 13】

A method of one of claims 2-9, wherein the dithering is performed according to an oscillating waveform of a saw-tooth wave.

【Claim 14】

A method of one of claims 2-9, wherein the dithering is performed according to an oscillating waveform of a trapezoid-wave.

【Claim 15】

A method of claim 1 or claim 2, wherein the laser beam is of an oval shape having a major axis along a scanning direction.

【Claim 16】

A method of claim 15, wherein the laser beam has its major axis of 200-500μm and a minor axis of 15-50μm.

【Claim 17】

A method of claim 1 or claim 2, an insulating layer is provided between the first electrode layers for preventing electric interference of electrode layers.

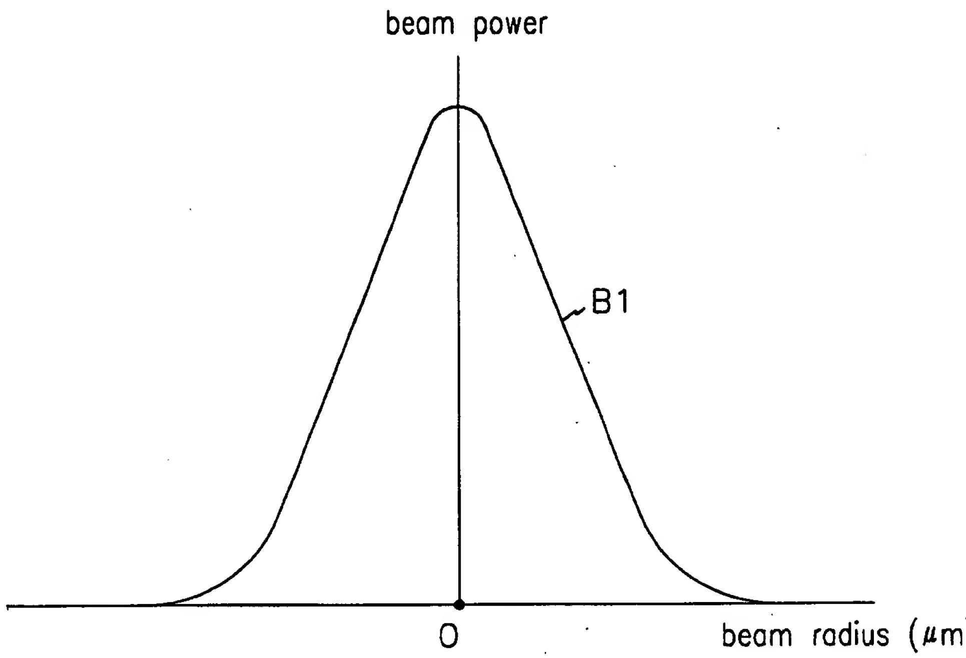
【Claim 18】

A method of claim 1 or claim 2, wherein the organic luminescent layer is made of a poly phenylene vinylene (PPV)-based material.

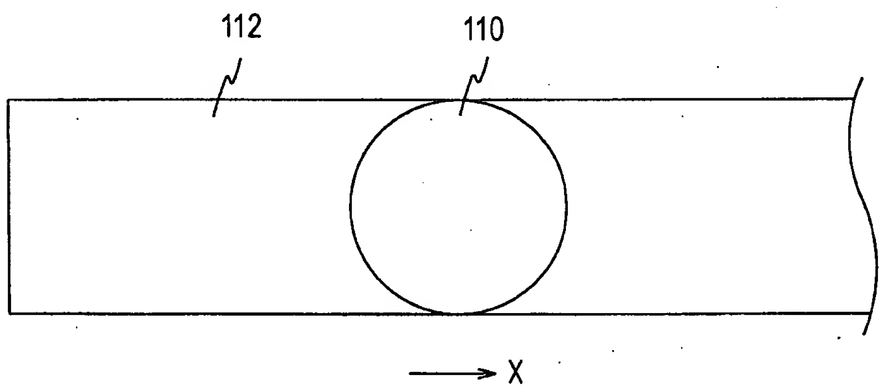
【Claim 19】

A method of claim 1 or claim 2, wherein the organic luminescent layer is made of a polyfluorene (PF)-based material.

【fig. 1】



【fig. 2】



【fig. 3】

forming a first electrode layer

↓

forming an assistant layer

↓

forming an organic luminescent layer by dithering a laser beam

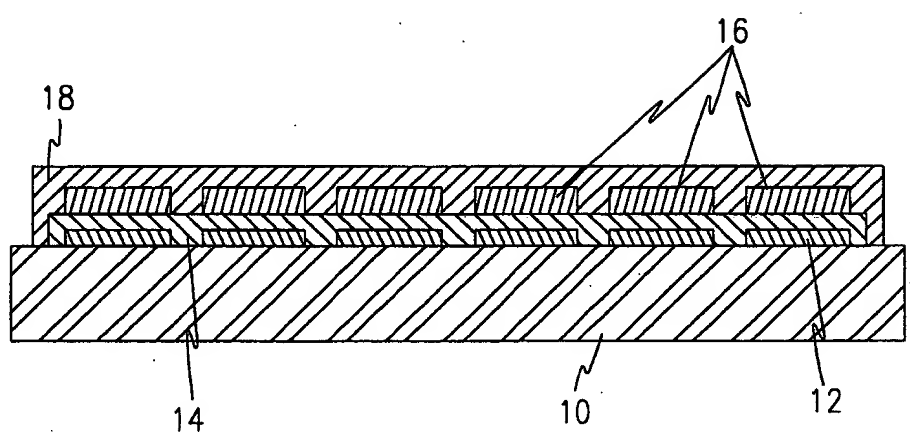
↓

removing a donor film

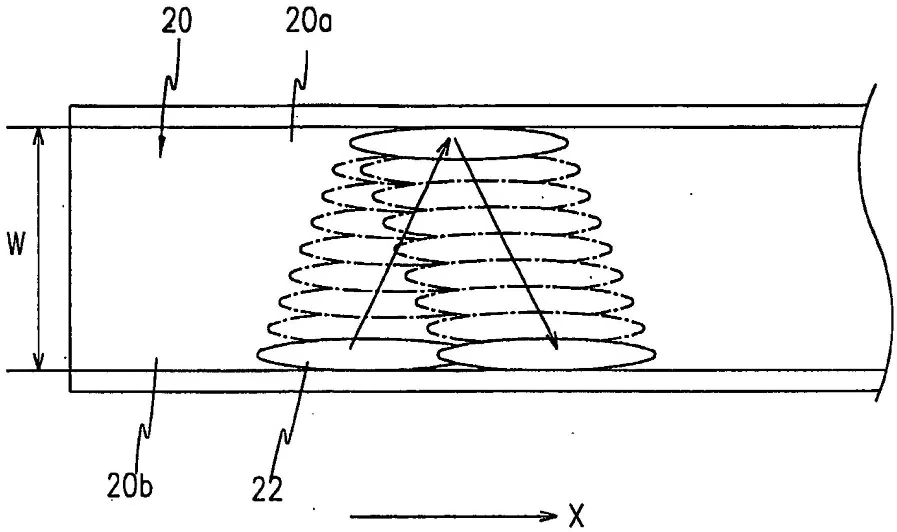
↓

forming a second electrode

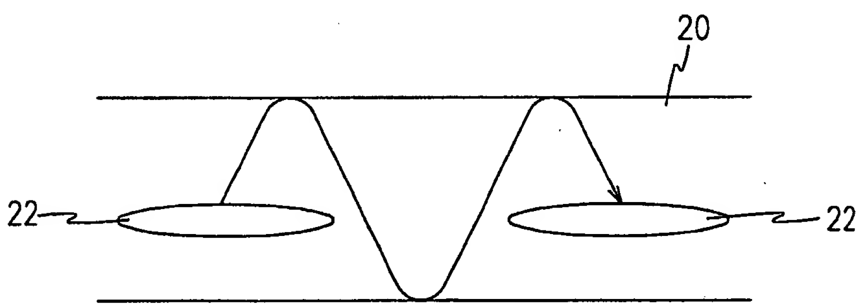
【fig. 4】



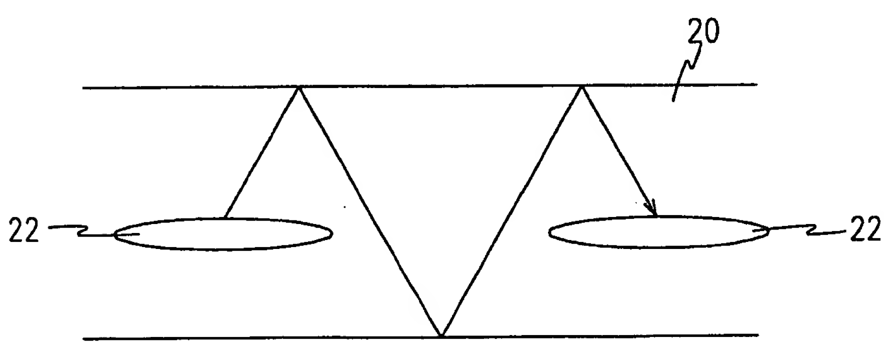
【fig. 5】



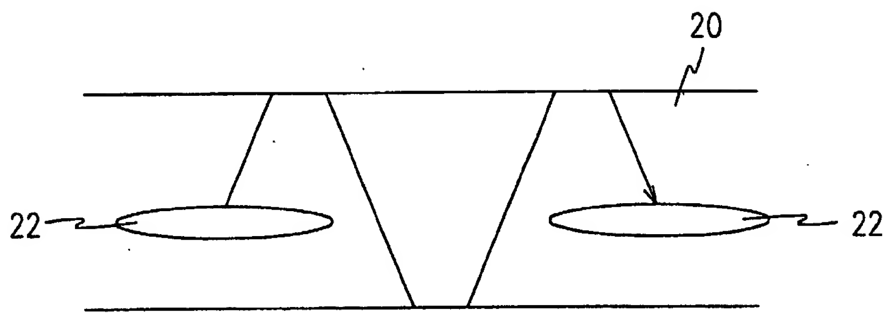
【fig. 6】



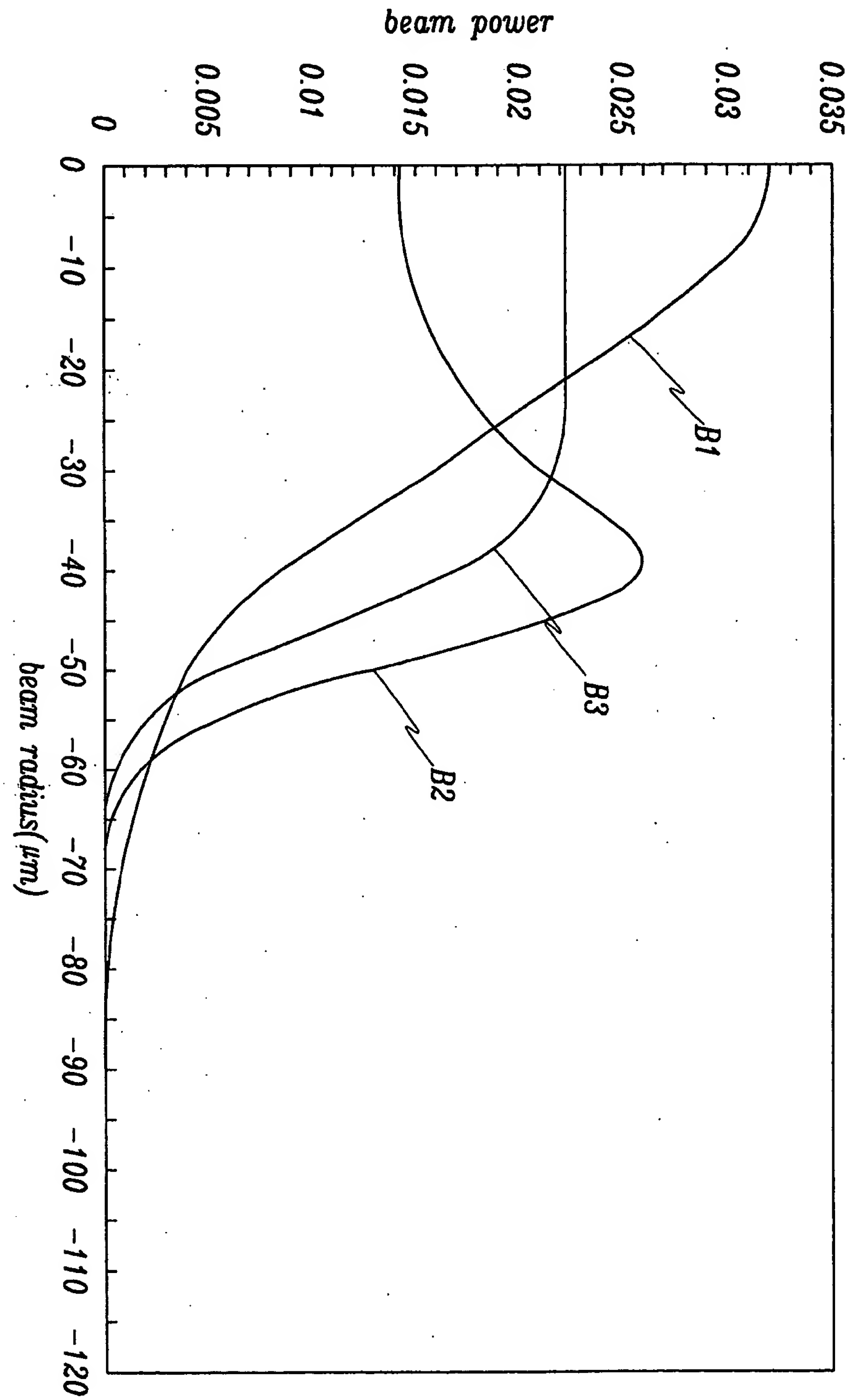
【fig. 7】



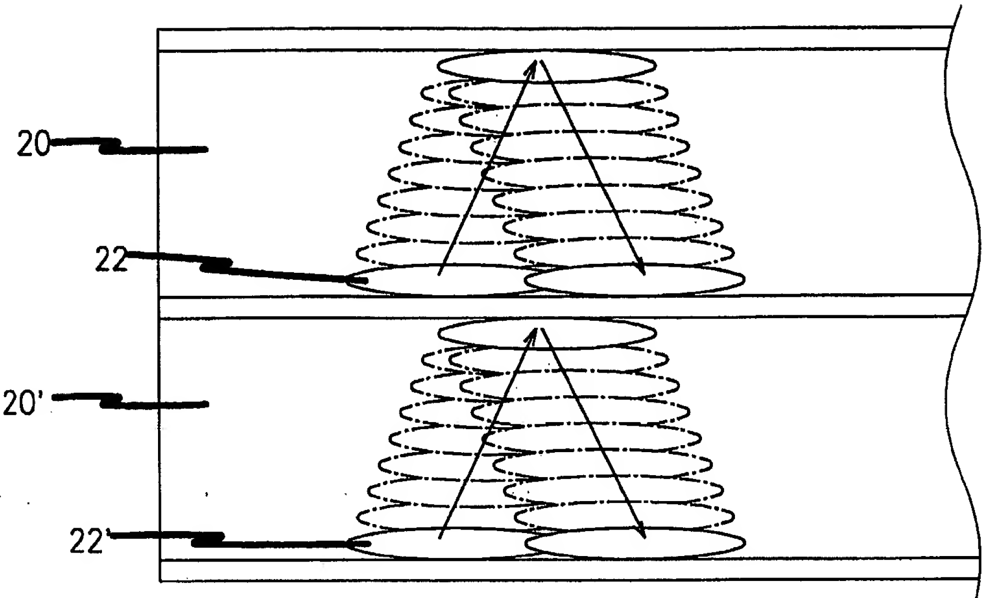
【fig. 8】



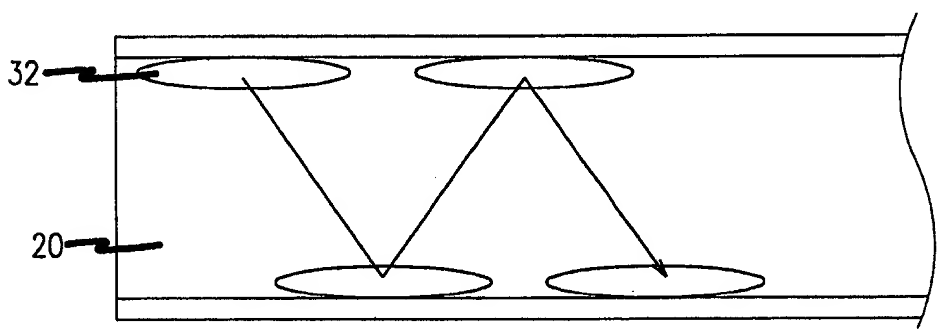
【fig. 9】


beam power
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
beam radius(μm)
B1
B2
B3

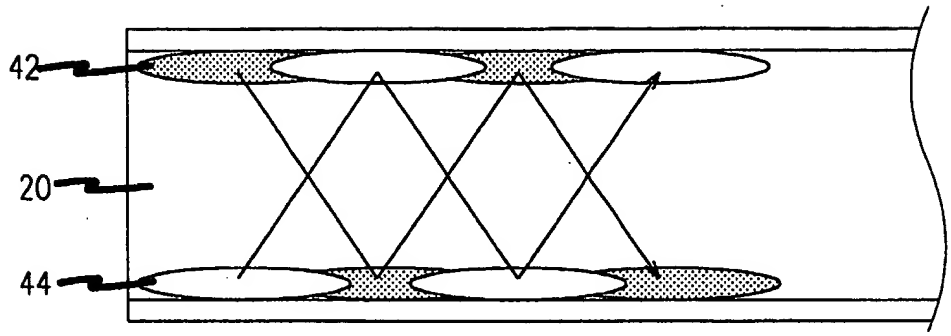
【fig. 10】



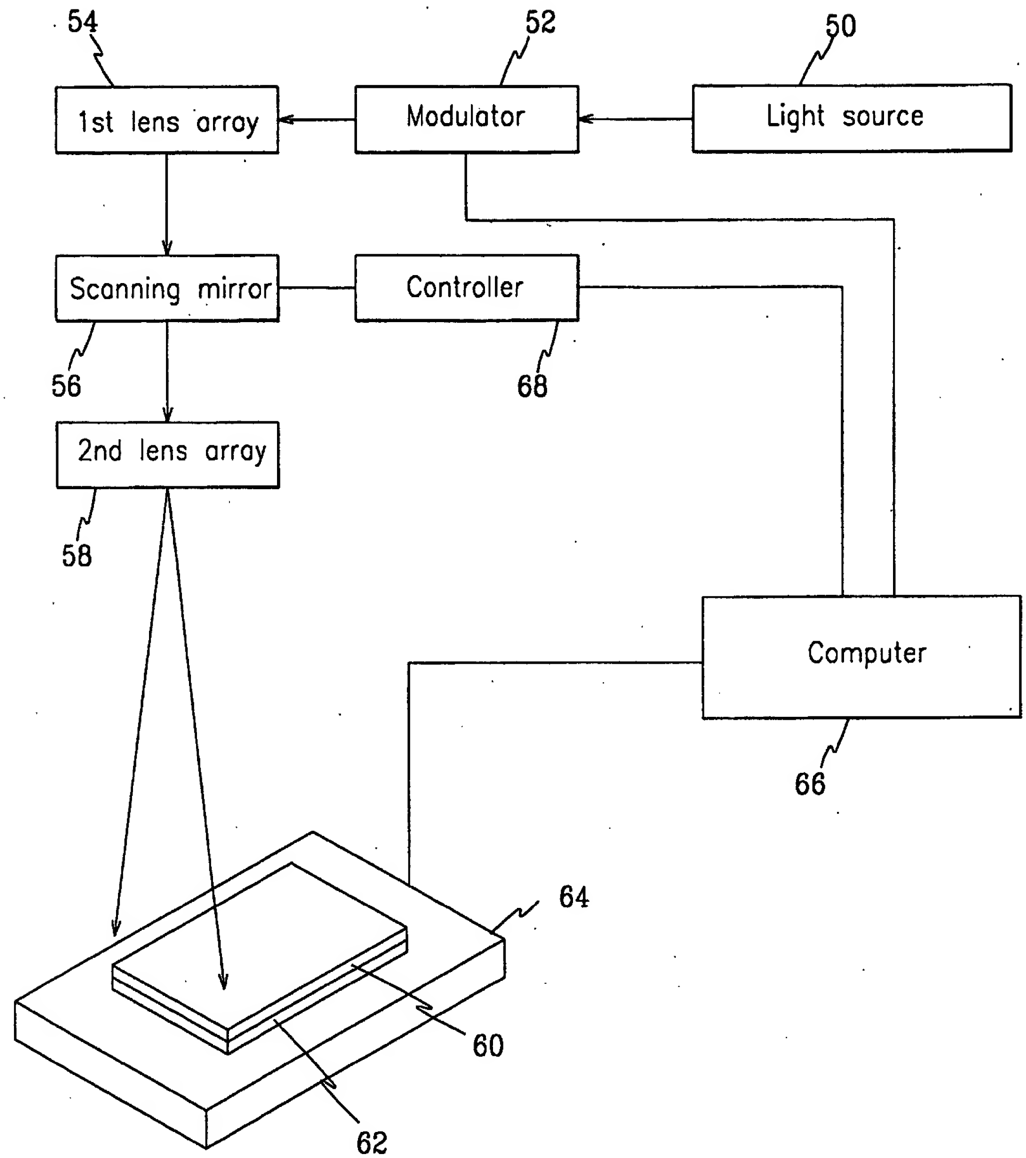
【fig. 11】



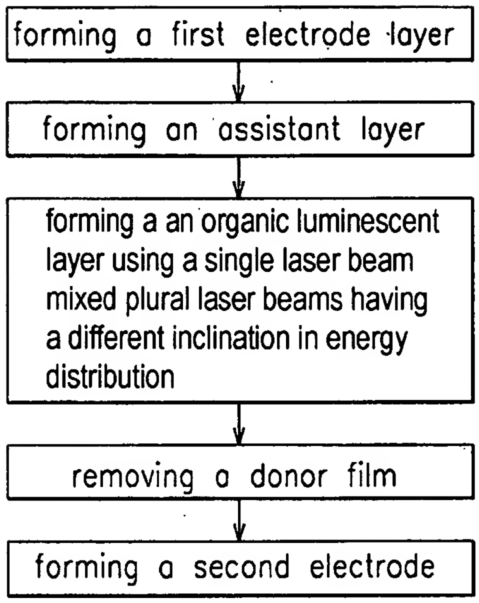
【fig. 12】



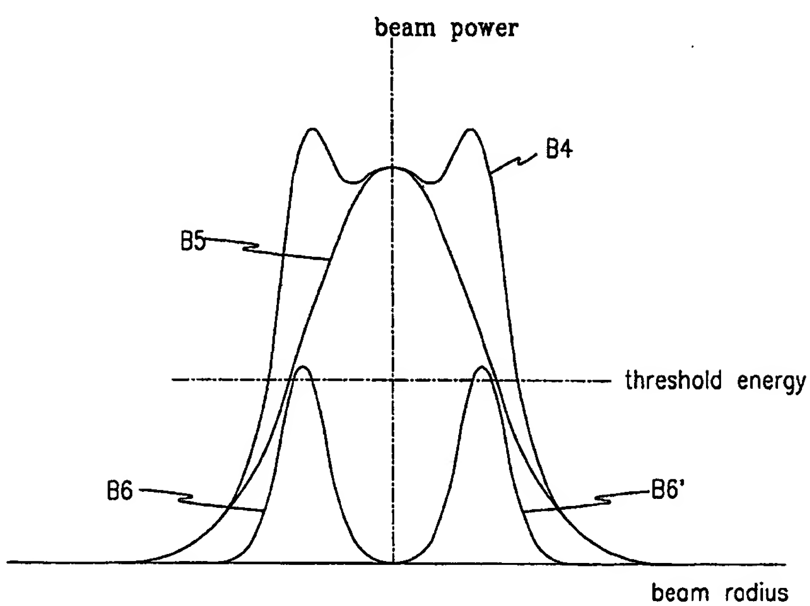
【fig. 13】


54
52
50
1st lens array
Modulator
Light source
Scanning mirror
Controller
56
68
2nd lens array
58
Computer
66
64
60
62

【fig. 14】


forming a first electrode layer
forming an assistant layer
forming a an organic luminescent layer using a single laser beam mixed plural laser beams having a different inclination in energy distribution
removing a donor film
forming a second electrode

【fig. 15】


beam power
B4
B5
threshold energy
B6
B6'
beam radius